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NEW FREQUENCY STANDARD TEST FACILITY

JPL has developed a facility for measuring the performance of ultra-precise frequency standards to within 1 part in 10^{16}. This Interim Frequency Standard Test Facility (IFSTF), the only fully operational one of its kind in the United States, provides the extremely stable environment required for measuring this performance.

Future deep space missions will rely on frequency and timing standards which are stable to 1 part in 10^{16} over 10^3 to 10^5 seconds. This accuracy will lead to more precise or lower cost spacecraft navigation, increased knowledge of the characteristics of the interplanetary propagation medium, and an enhanced probability of detection of gravity waves.

Frequency stability in the range of 1 part in 10^{13} to 10^{15} over 10^3 to 10^4 seconds is achievable from current state-of-the-art frequency standards. These stabilities can only be obtained by using atomic frequency standards, such as a hydrogen maser, coupled with sophisticated environmental control. These standards are still sensitive to small temperature changes, despite thermal control of critical internal components. Further, because of the extraordinary stability aimed for, no instrumentation existed in the United States to measure the frequency and timing stability of these standards.

The new facility meets these needs. It contains two key features: extreme temperature control and ultra-stable instrumentation. Ambient temperature is controlled to within ±0.05 degrees Celsius over 24 hours. Control to ±0.01 degree Celsius is available within special test chambers. Temperature can also be varied as required over a 30 degree Celsius range. Instrumentation stable to 1 part in 10^{16} may be used to evaluate up to 12 frequency standards simultaneously. Two reference hydrogen maser standards are maintained within the facility as references.

Stability curves have been measured showing the variance of measured frequency differences between two hydrogen masers, with and without the extreme temperature control of the facility, over the course of a day. Only with the temperature control can the 10^{15} level of stability be achieved at 10^4 seconds. A stability of 6 parts in 10^{16} at 3 x 10^3 seconds is the best achieved by any JPL hydrogen maser.

Figure (opposite page): Interior of the new Frequency Standard Test Facility, whose extraordinary temperature and magnetic field controls make it possible to measure the frequency standard performance of hydrogen masers within one part in 10^{16}. The two wooden cabinets in the photograph contain hydrogen masers. One cabinet is encircled with coils that produce a magnetic field capable of changing the magnetic environment. Also shown are floor plenums for forced air.